

Soft X-rays, white-light emission and densities in stellar flares with XMM-Newton

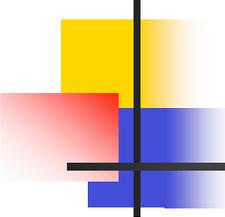
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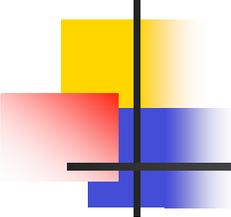
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Overview

- ✓ White-light flares in the Sun and stars
- ✓ UV/optical and soft X-ray lightcurves of YZ CMi, EV Lac and AT Mic
- ✓ Density and temperature estimation with OVII triplet
- ✓ Correlations

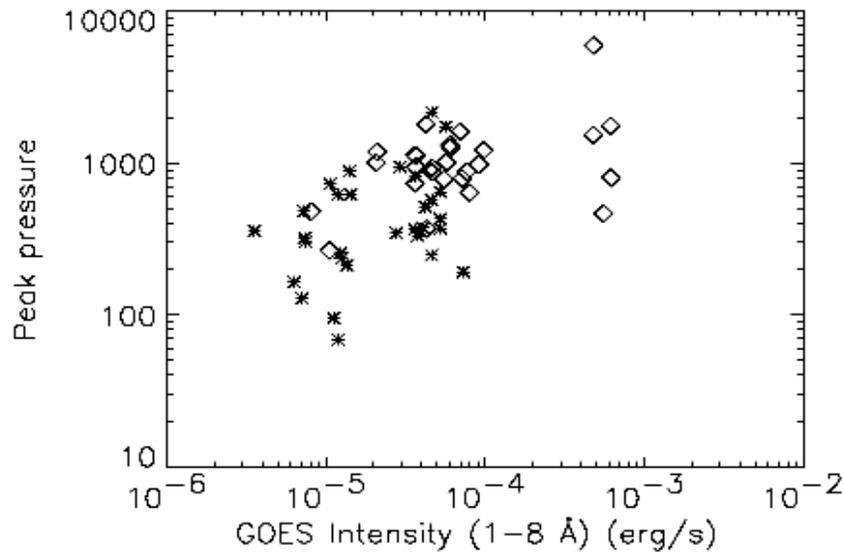
A decorative graphic consisting of overlapping colored squares (yellow, red, blue) and a black crosshair.

White light flares

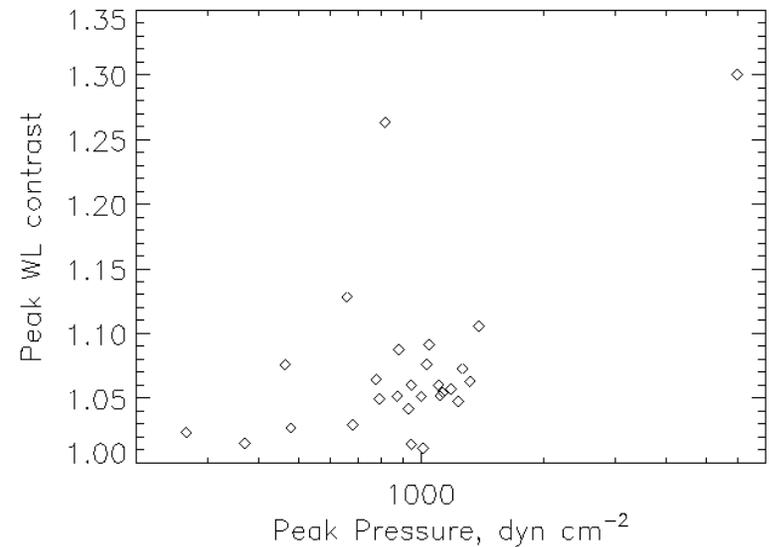
- ✓ Flares: Hard and soft X-ray energy release from reconnection in lower corona
- ✓ Some flares also show white-light (WL) emission
- ✓ White-light flares often observed in stars
- ✓ Rarely observed on Sun
- ✓ Only high intensity events show WL ?

The Sun: WL vs pressure

- So far, only observed correlation with WL is coronal over-pressure (Matthews et al. 2003)



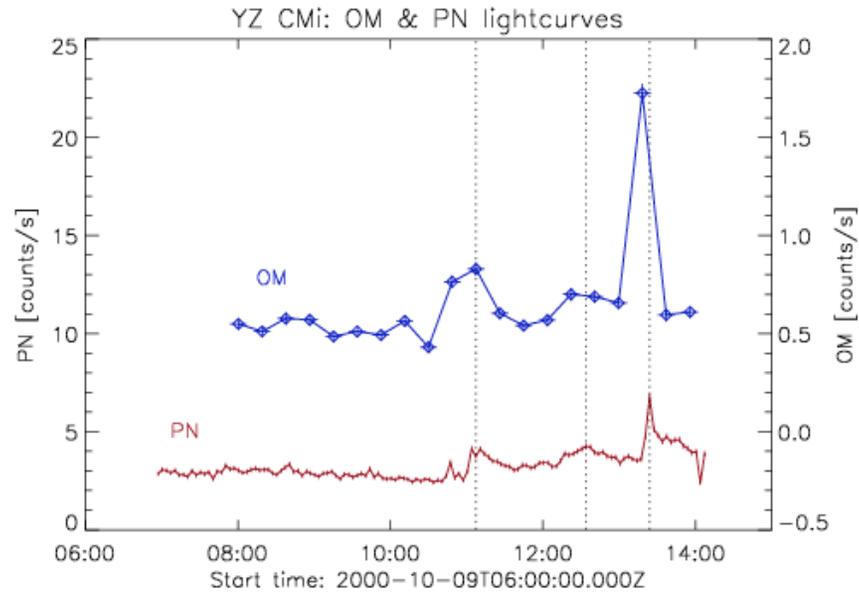
Diamonds: WL flares; Stars: Flares without WL



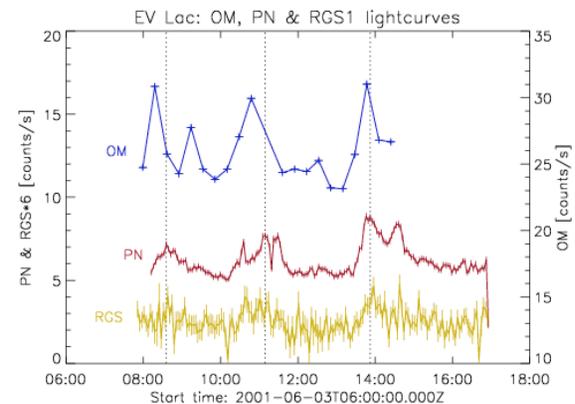
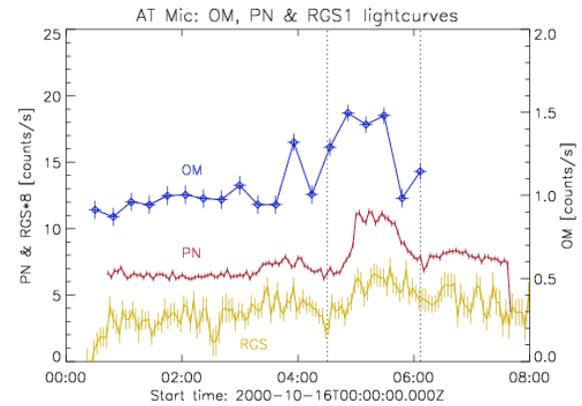
WL flares only

Lightcurves

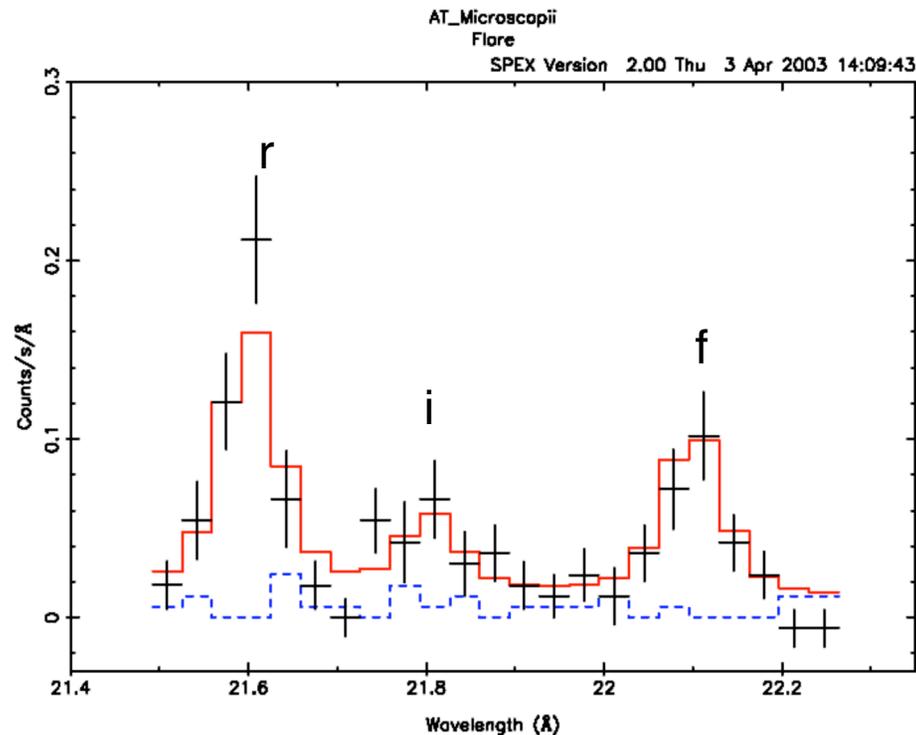
YZ CMi, AT Mic, EV Lac: dM4.5e stars



- PN: 0.2 – 10 keV
- RGS: 0.3 – 2.1 keV (38 – 5 Å)
- OM Filter: UVW2 180 – 225 nm, UVW1 225 – 350 nm
- OM flux: Integrated over 800s



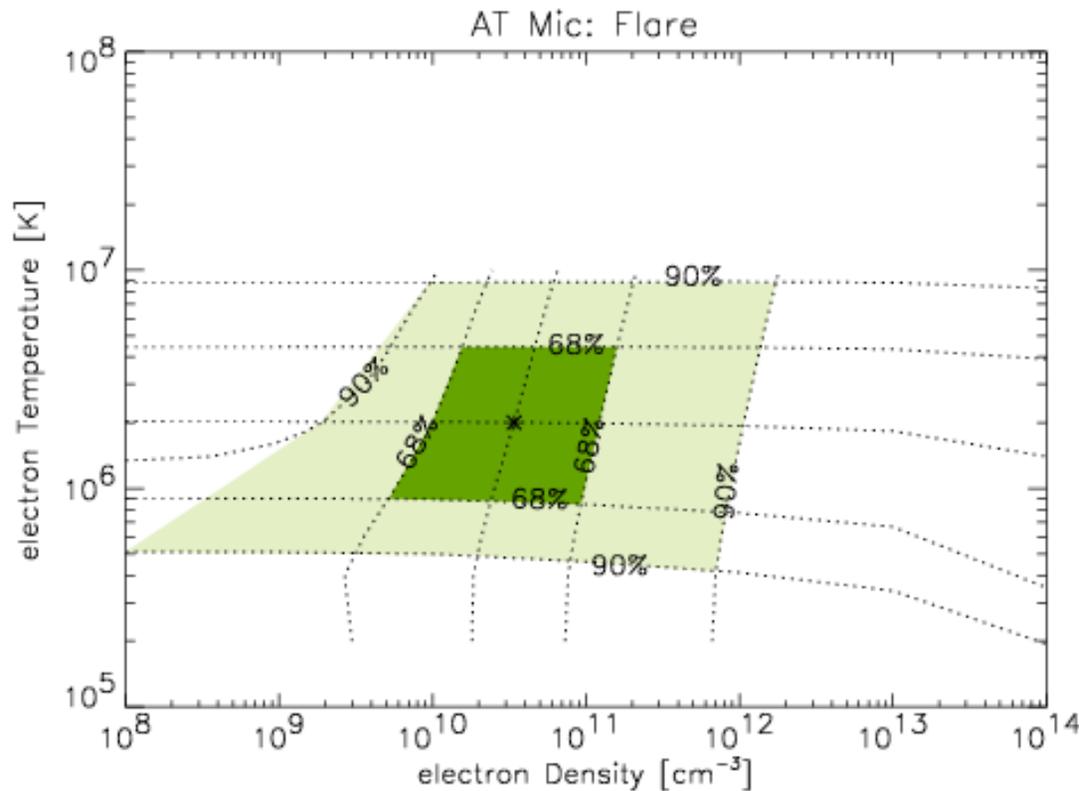
Density diagnostic: OVII triplet



- ✓ R-ratio
 - ✓ $R = f/i$
 - ✓ Density sensitive
- ✓ G-ratio
 - ✓ $G = (f+i)/r$
 - ✓ Temperature sensitive

Spex: Kaastra et al. (1996)

Density-Temperature Diagram



Chianti Database:
Dere et al. (1997)
Young et al. (2003)

$$n = n(r, T)$$

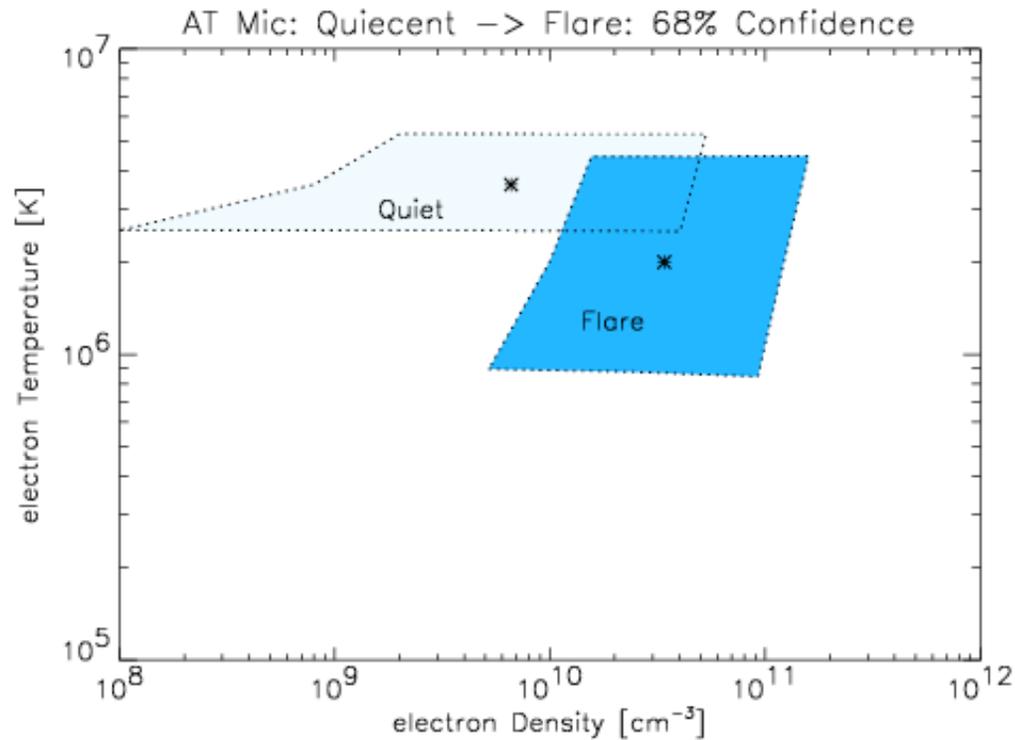
$$T = T(g, n)$$



$$T = T_r(n)$$

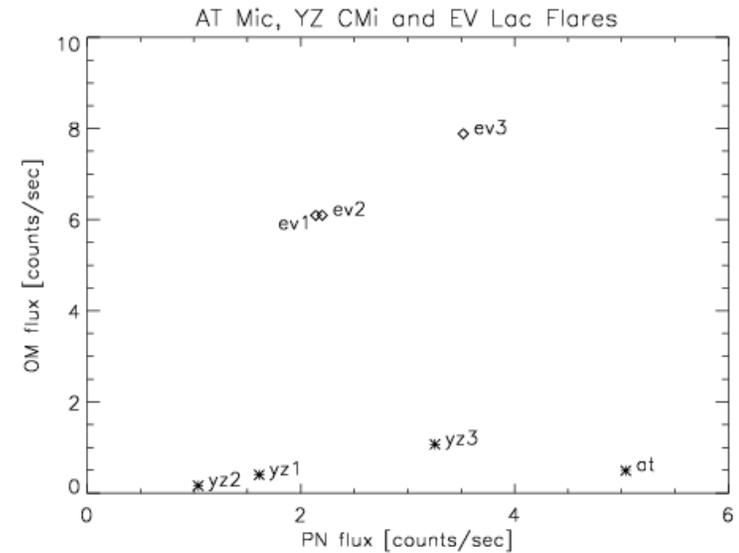
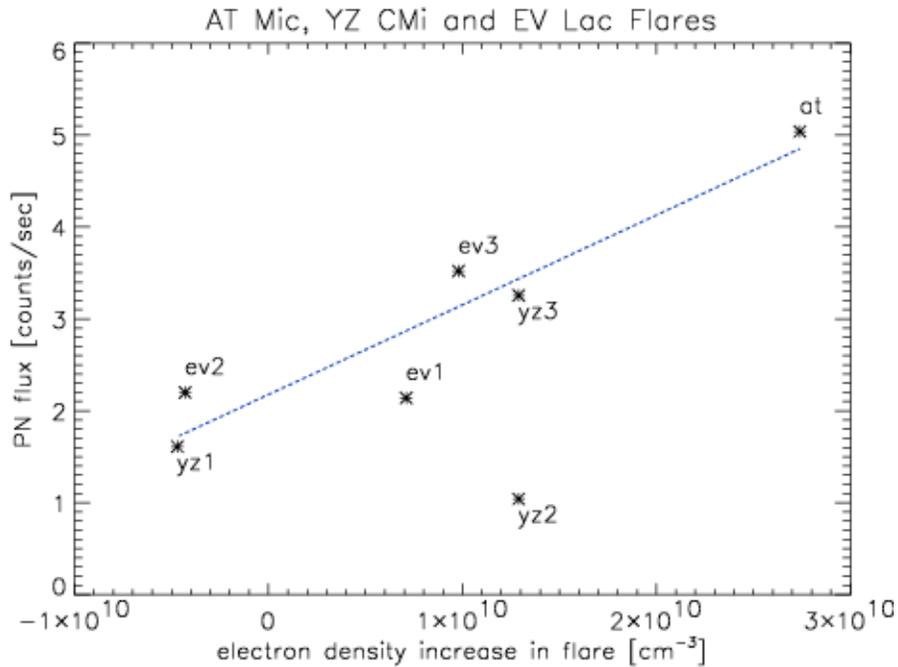
$$T = T_g(n)$$

Quiet vs Flare



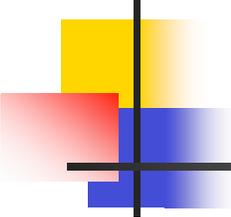
Good agreement with:
Raassen et al. (2003)
Atomic Database:
Porquet et al. (2001)

Relations



For stars:
Ness et al. (2002)

For the Sun:
e.g. Feldman et al. (1996)



Summary

- √ Correlation between white light and soft X-rays
 - √ Future: Better time resolution for optical
- √ Density increase during flare
 - √ Large errors because of low count rates
- √ Relationship between soft X-rays and density in flares (within errors)